Exploring Scientific Frontiers . . .

INSTITUTE FOR ADVANCED TECHNOLOGY (IAT)

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Introduction

In 1996, the movie *Eraser* showed Arnold Schwarzenegger using X-ray vision rail guns to help him destroy the "bad guys" as they attempt to kill a federal witness (Vanessa Williams). You told yourself it was just Hollywood, and those kinds of things don't really exist. Today, do you ever wonder if anyone pays attention to those seemingly impossible ideas? Could the Army ever benefit from them? The answer is yes to both questions.

Meet Dr. Harry Fair and his team at The Institute for Advanced Technology (IAT) at the University of Texas (UT) at Austin. IAT is the Army's University Affiliated Research Center (UARC) and, as such, serves the Army in its quest to advance into the 21st century and beyond. IAT's primary mission is the development of hypervelocity impact physics and electromagnetic (EM) technology for the Army. This is IAT's story.

Background

In March 1983, President Reagan made his famous speech advocating space-based missile defense (nicknamed "Star Wars"), which also became the genesis of the Strategic Defense Initiative (SDI). After his speech, there was tremendous focus on trying to solve the problems space-based weapons might encounter. Money and presidential priority gave a tremendous boost to the study of hypervelocity impact physics and EM technology for the next decade.

Hypervelocity impact is a term that encompasses events in which impact-generated pressures are well in excess of the projectile and target strength. In hypervelocities (normally above 3 kilometers per second), shock dynamics become important to the point that they can dominate the overall response of projectile and target. In layman's terms, the whole "ball game" of physics changes at hypervelocities.

In 1986, the Secretary of Defense characterized the challenge of Warsaw Pact armor as one approaching a matter of "national urgency." He directed the Defense Advanced Research Projects Agency (DARPA) to establish the Joint Armor/Anti-Armor Program to redress the technology imbalance between the East and West.

UT-Austin has long been associated with Defense-related basic and applied research projects. To compliment Reagan's SDI initiative in 1983, UT constructed a facility at the Center for Electromechanics (CEM) to support both the new SDI and DARPA initiatives. In the late 1980s, Star Wars began to lose U.S. and world public support. By 1986, Defense officials thought research efforts concentrating on ground-based weapons were more prudent than putting weapons in space.

Concurrently, the UT Chancellor requested Fair—who was employed at DARPA—to come to UT to assist in establishing a Federally Funded Research and Development Center (FFRDC) for the Army. While at DARPA, Fair had helped establish kinetic energy efforts for the SDI Office and had led armor and anti-armor efforts.

IAT's History

IAT was established at UT in 1990 as the U.S. Army's only FFRDC to study hypervelocity physics and electromagnetics. It was a giant step for both UT and the Army, and marked the beginning of significant accomplishments in the enabling technologies for development of practical EM launchers.

In 1995, IAT transitioned from an FFRDC into one of the Army's UARCs. This allowed IAT increased flexibility to quickly react to key weapon systems issues and provide scientific underpinnings for a new family of electric weapon systems. IAT and CEM continue their teamwork today and provide added synergy to address the Army's future scientific challenges.

Partnering Efforts

To perform this important work, IAT has teamed with some of the best scientists in the world whose efforts have primarily been focused on long-

term basic and applied research and development (R&D). Key focus areas are hypervelocity physics, directed energy, electrodynamics, electromagnetic and electrothermochemical launchers, hypersonic aeroballistics, technology integration, and the application of advanced systems information technology into military systems.

IAT also partners with UT not only in science endeavors, but also in educational ones. UT opens its laboratories to West Point cadets, researchers, university faculty, and selected research fellows. IAT also sponsors graduate fellows from the Army War College during their 1-year-long program, as well as national and international symposia related to IAT's interests.

For the majority of its R&D efforts, IAT is partnered with the Army Research Laboratory (ARL) in Adelphi, MD. With work centered on basic (6.1) and applied (6.2) research, both ARL and IAT have joined in a number of efforts involving the study of advanced materials, electric weapons concepts, the effects of hypervelocity rounds on armor, and the propulsion and flight dynamics of those rounds. Breakthroughs in pulsed power supply and energy management have enabled IAT to help the Army develop a new paradigm for advanced combat vehicle design.

For example, in recent years, the greatest single problem of designing EM guns for vehicles has been constructing a power supply small enough to fit into the cube space within an armored vehicle. In view of the prohibitive capacitor-based systems, inertial storage of energy in high-speed rotors is integrated with electric-pulse generators. These "pulsed-power" generators have the added capability of providing a relatively low signature for the EM gun, and they can be used to power electric weapons, electric drive motors, electric suspension systems, and electric armor, thus reducing the number and weight of other traditional components.

To help ARL determine which technologies provide the payoff needed and to quantify the trade-offs associated with different weapon systems approaches, focused efforts were required to develop both an understanding of current state-of-the-art technologies and potential attributes of emerging concepts related to Army-specific applications and multiuse functions. IAT developed a nationally recognized capability for modeling and simulation (M&S) of combat vehicles under realistic, dynamic mission conditions referred to as POWERSIM.

Beyond POWERSIM, IAT developed a system-level modeling code—named the Electromagnetic Launch Package (EMLP)—for designing and sizing launcher and kinetic energy projectiles for EM weapons. Another model called TRAJ is an external ballistics tool that, when joined with EMLP, allows for end-to-end EM gun-to-target-level simulation and analysis.

In addition to pure M&S, IAT has been involved in the development and testing of actual hybrid electric vehicles for use in building and verifying their M&S tools. Further, combinations of these simulations and vehicles are also able to provide data to organizations such as the Tank-automotive and Armaments Command (TACOM) for use in fuel-consumption studies. M&S has become an important aspect of designing Future Combat Systems (FCS) because it enables a wide range of FCS vehicle types to be evaluated at a fraction of the cost of designing and building them. In addition to helping the Army determine the characteristics of its FCS, IAT has provided valuable research to other Army partners and in other areas of interest.

Other Support Efforts

Another important endeavor is a University XXI Consortium (comprised of Texas A&M and the IAT at UT-Austin) that has significant computer science and M&S expertise to support the Army's digitization efforts. The consortium has focused on brigade commanders and staffs. By conducting a front-end analysis of battle staff tasks and correlating this to the digitized Mission Essential Task List, IAT has aided in modeling battalion staff activities that use simulation rather than exercise controllers to support brigade-level training events. Examples of other continuing efforts include researching sensible agents for potential application as low-overhead digital battlefield staff drivers, and the development of a training and operational data synchronizer for populating databases in fielded systems and to support training and testing simulation systems.

IAT has also embarked on an effort to expand, enhance, and improve the ability of DOD and other federal agencies to address chemical and biological terrorism and to protect U.S. and allied forces from chemical or biological threats. IAT has assembled an integrated team of experts from leading universities, medical centers, the military, the Departments of Justice and Health, and other organizations to promote the rapid transition of developed technology, training, and strategies into the hands of those who will be directly affected during an emergency. IAT's goal is to help the appropriate federal, state, and county agencies develop advanced sensors, appropriate communications nodes, and physical and medical countermeasures to effectively deal with and respond to these potential threats.

Conclusion

Where will the IAT team go from here? Since its inception, IAT has provided the Army with the ability to surpass numerous barriers in the study of hypervelocity impact physics and EM technology. Other applications of this science extend to the destruction of oncoming near-Earth asteroids; protection of space-based satellites, space stations, and other objects against hypervelocity "space junk" and debris; and launchers that will deliver payloads into space without using traditional rocket fuels as the means of propulsion.

The IAT team continues to play a vital role in helping the Army explore the frontiers of science, maintain its pace with technology, and exploit advances in science and technology for its future weapons systems.

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